

## Potential Role of Transoral Laser Surgery for Larynx Carcinoma

Hans Edmund Eckel, MD,\* Christoph Schneider, MD,  
Markus Jungehülsing, MD, Michael Damm, MD, Ursula Schröder, MD, and  
Martin Vössing, MD

Department of Otorhinolaryngology, University of Cologne, Cologne, Germany

**Background and Objective:** The treatment of larynx carcinoma is not settled to date. This prospective study evaluates the potential role of transoral laser surgery (TLS) for larynx carcinoma in a large series of unselected patients from a single institution.

**Materials and Methods:** A total of 504 consecutive patients with previously untreated carcinoma of the larynx were seen from 1986–1994. Their treatment modalities and results were prospectively evaluated.

**Results:** TLS was used in 290 patients (58%), total laryngectomy in 130 (26%), conventional partial laryngectomies in 31 (6%), and radiotherapy in 34 (7%). Nineteen (4%) had no curative treatment. Uncorrected actuarial survival for all patients with glottic carcinoma stages I and II treated with laser surgery ( $n = 202$ ) was 80.2%, cause specific survival 96.7%, and local control 85.8%. Uncorrected actuarial survival for all patients with supraglottic carcinoma stages I and II treated with laser surgery ( $n = 40$ ) was 49.0%, cause specific survival 78.6%, and local control 87.3%. **Conclusion:** TLS was the most important single treatment modality in this large series of unselected patients. It is a safe and time- and cost-effective alternative to radiotherapy for early stage larynx carcinoma. *Lasers Surg. Med.* 23:79–86, 1998.

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**Key words:** larynx neoplasms treatment; larynx carcinoma; laser surgery; laryngectomy; head and neck cancer; surgical oncology; minimally invasive surgery

### INTRODUCTION

The treatment of larynx carcinoma is not settled to date [1]. Primary treatment protocols for early stage disease (stages I and II) usually include surgery or radiotherapy as single agents [2–4]. Advanced stages may be treated with surgery alone, with combinations of surgery and postoperative radiation, or with radical radiotherapy and surgical salvage [1,5–7].

Two novel approaches to the treatment of the disease have contributed to the spectrum of therapeutic options during the past two decades: transoral laser surgery (TLS), mostly used for early stage carcinoma, and sequential or concomitant chemotherapy and radiotherapy for organ preservation in advanced stages [8–16].

TLS provides advantages relating to its hemostatic effects and precision of tissue ablation. It has been reported to cause minimal morbidity and good functional results and to provide a cost-effective alternative to open surgical procedures and to radiotherapy [11,14,17]. Therefore, it is now a widely used surgical approach to small, midcordal glottic carcinoma. Moreover, successful treatment of stages II and III lesions of the vocal

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\*Correspondence to: Hans Edmund Eckel, MD, Universität-HNO Klinik, D-50924 Koeln, Germany. E-mail: hans.eckel@uni-koeln.de

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TABLE 1. Treatment Modalities of 504 Patients With Larynx Carcinoma

		Laser surgery	Partial laryngectomy	Radiation therapy	Total laryngectomy	No treatment/symptomatic treatment	Total
Localization	Stage						
Glottis	Ca in situ	26	0	0	0	2	28
	I	136	2	6	0	0	144
	II	66	6	2	6	2	82
	III	4	0	1	38	3	46
	IV	0	0	0	12	0	12
Subtotal		232	8	9	56	7	312
Supraglottis	I	10	0	1	0	2	13
	II	30	3	0	12	3	48
	III	6	4	0	27	0	37
	IV	3	16	23	29	6	77
Subtotal		49	23	24	68	11	175
Subglottis	I	2	0	0	0	0	2
	II	7	0	0	2	0	9
	III	0	0	1	2	0	3
	IV	0	0	0	2	1	3
Subtotal		9	0	1	6	1	17
Total		290	31	34	130	19	504

folds and of selected supraglottic cancers have recently been reported in the literature [18–20]. Although the data presented in these studies indicate that transoral laser surgery leads to oncological results that are comparable to more conventional treatment modalities in selected groups of patients, the potential role of laser surgery for larger series of unselected cases has not been settled to date.

This prospective study evaluates the potential role of transoral laser surgery (TLS) for larynx carcinoma by reporting the treatment modalities and results in a large, unselected group of 504 consecutive patients from a university-based referral center that uses transoral laser surgery as the standard approach to larynx carcinoma classified T1/T2.

## MATERIALS AND METHODS

### Patients and Treatment Selection

A total of 504 patients with previously untreated squamous cell carcinoma of the larynx were seen at the Department of Otorhinolaryngology, University of Cologne, Germany, from January 1, 1986, to December 31, 1994. These prospectively treated patients constitute the subject of this investigation. The treatment protocol included transoral laser resection of the primary cancer for lesions classified T1/T2 that were judged to be endoscopically accessible; conventional vertical or horizontal partial laryngectomy for these lesions if they were not completely ac-

cessible endoscopically; total laryngectomy (with partial pharyngectomy, if necessary) for most lesions classified T3/T4; and radiotherapy for those patients not suited for, or rejecting surgery. Patients with supraglottic carcinoma classified T3/T4 occasionally had resections of their primaries via a transoral approach or by conventional supraglottic laryngectomy, if both vocal cords were mobile.

All patients underwent staging endoscopy of the pharynx, larynx, esophagus, and oral cavity to permit detailed assessment of the tumor and to rule out synchronous coexisting primaries. Patients with advanced tumors had computed tomographic scanning of the upper aerodigestive tract. Patients with carcinoma of the hypopharynx extending to the larynx were not included in this series. Distribution of stages of the disease and treatment modalities according to stages are given in Table 1.

Patients with stages III and IV glottic carcinoma had uni- or bilateral neck dissection together with total laryngectomy. All patients with subglottic and supraglottic carcinoma were offered bilateral neck dissection independent of the kind of surgical procedure used to treat the primary. If open surgical procedures were performed, the neck dissection were performed synchronously. If transoral procedures were chosen to treat the primary, neck dissections were staged for 1–2 weeks. Additional postoperative radiotherapy was administered if lymph node metastases were histologically evident, or if patients re-

fused neck dissections that had been recommended as a part of the above mentioned treatment protocol ( $n = 9$ ).

### Surgical Technique

For all of the transoral procedures reported here, a CO<sub>2</sub> surgical laser (different models supplied by Laserscope, San Jose, CA; Sharplan Industries, Merit House, London, UK) was used coupled with a Zeiss operating microscope with a 400 mm lens, allowing for precise coaxial delivery of both the helium-neon aiming beam and the CO<sub>2</sub> cutting beam to the operative field (Carl Zeiss, Thornwood, NY). From 1993 onward, an acuspot micromanipulator was used to allow a more precise focusing of the laser beam. Spot size varied from 0.3 mm to 0.8 mm. Lasers were consistently used in the so-called superpulse mode. With this modification in laser beam delivery, light is not emitted continuously, but in pulses of a maximum possible peak power of 30–60 W depending on the surgical laser used. The mean output power varied from 2–8 W depending on the micromanipulator system. The microscope laser head and the operating table were positioned repeatedly to give optimal exposure of the surgical field. Larger vessels that could not be coagulated by the laser were managed by monopolar cautery. Different types of laryngoscopes, including adjustable operation laryngoscopes (Storz Medical Instruments, Tuttlingen, Germany), were used for optimal exposure of the laryngeal structures. Tumors were resected en block to facilitate histologic examination of all margins. After complete resection of the tumor, the excised area was allowed to heal by second intention. If minor diffuse bleeding was noted at the end of the procedure, such wounds were covered with fibrin glue.

### Statistical Methods

Five-year actuarial survival was determined without correction for age or intercurrent death from the date of initiation of therapy (the date of the primary operation or the date of initiation of radiotherapy) until the date of the last follow-up examination, or death, respectively. For the cause-specific actuarial survival analysis (tumor-related survival), patients dying disease-free of unrelated causes were censored at the time of their death. Local control, loco-regional control, and organ preservation rates (survival with larynx preservation) after 5 years were calculated likewise. Follow-up data were available for all patients. A total of 459 patients (91.1% of the 504)

were followed until death (for those who died) or until December 31, 1995. The remaining patients were censored on the date of their last available follow-up. No patient was excluded from statistical analysis. Even the 19 patients who had no curative treatment for various reasons were included in the data analysis. Patients with unknown disease status at their date of death were documented as disease-related death. The follow-up ranges from 4–109 months (median: 42 months).

In addition, uncorrected actuarial survival, actuarial cause-specific survival, local control, local and regional control, and organ preservation rates were calculated as previously noted for all patients with glottic carcinoma stages I and II and with supraglottic carcinoma of these same stages. Survival rates were computed by using the product-limit estimator of Kaplan & Meier. Data were analyzed using the SPSS for windows (statistical package for the social sciences) statistical software package version 6.1.3.

## RESULTS

### Treatment Modalities

As noted previously, 504 patients with larynx carcinoma were treated prospectively between 1986 and 1994. Of those, 312 (61.9%) presented with glottic cancer, 175 (34.7%) with supraglottic, and 17 (3.4%) with subglottic carcinoma. Twenty-eight patients (5.5%) had carcinoma in situ, 159 (31.6%) were attributed stage I, 139 (27.6%) stage II, 86 (17.1%) stage III, and 92 (18.2%) stage IV. Transoral surgery was used in 290 patients (57.5%) to treat the primary, total laryngectomy in 130 (25.8%), conventional partial laryngectomies in 31 (6.1%), radiotherapy in 34 (6.8%), and 19 patients (3.8%) had no curative treatment. Distribution of stages of the disease and treatment modalities according to stages are given in Table 1.

### Survival, Local, and Regional Control

All patients were followed up for 12–109 months (median: 62 months) unless they died. Five-year uncorrected actuarial survival was 62%, and cause-specific actuarial survival was 80% for all 504 patients. Of all patients, 55% had their larynx preserved after 5 years. Figures 1–7 show 5-year survival curves as computed by using the product-limit estimator of Kaplan & Meier for all patients (uncorrected actuarial survival and

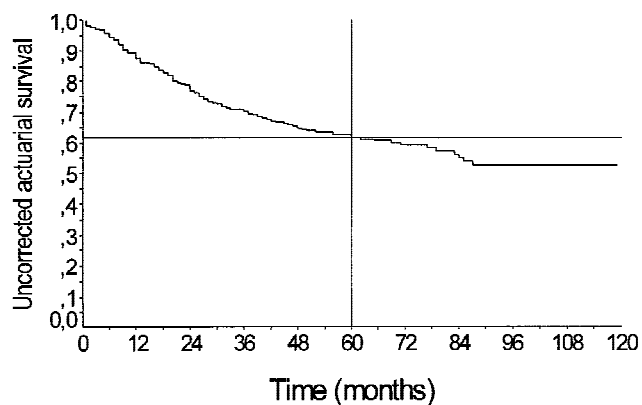


Fig. 1. Uncorrected actuarial survival—all patients (n = 504).

cause-specific actuarial survival) and for five subsets of the total patient population (all glottic tumors, all supraglottic tumors, all glottic tumors stages I,II, all supraglottic tumors stages I,II, and all glottic tumors categorized  $T_2N_0M_0$ ). In the group of patients with glottic carcinoma categorized  $T_1N_0M_0$  treated with laser surgery (n = 136), only one tumor-related death occurred during the follow-up period of this study. Therefore, no statistically meaningful graph can be generated for this subset of patients. However, cause-specific survival was calculated to be 99.2% for this subset.

Uncorrected actuarial survival for all patients with glottic carcinoma stages I and II treated with laser surgery (n = 202) was 80.2%, cause-specific survival 96.7%, local control 85.8%, loco-regional control 85.2%, and survival with larynx preservation, 91.72%.

Uncorrected actuarial survival for all patients with supraglottic carcinoma stages I and II treated with laser surgery (n = 40) was 49.0%, cause-specific survival 78.6%, local control 87.3%, loco-regional control 83.0%, and survival with larynx preservation, 71.0%.

Cause-specific actuarial survival for the 136 patients with  $T_1N_0$  vocal fold carcinoma treated with laser surgery was 99.2% and survival with larynx preservation was 90.7% after 5 years. Cause-specific actuarial survival for the 66 patients with  $T_2N_0$  vocal fold carcinoma treated with laser surgery was 92.3% and survival with larynx preservation was 90.6%.

Detailed data on the oncological outcome of all patients (n = 13) who had TLS as a part of their initial curative treatment for larynx carcinoma stages III and IV are condensed in Table 2.

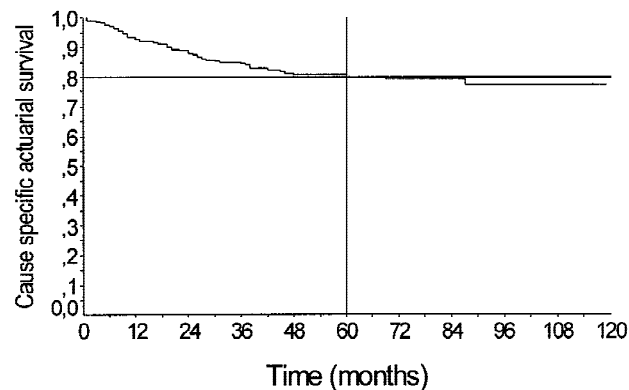


Fig. 2. Cause-specific actuarial survival—all patients (n = 504).

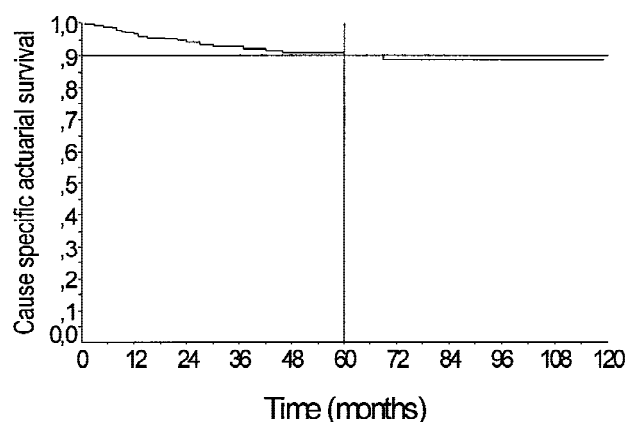


Fig. 3. Cause-specific actuarial survival—all patients with glottic carcinoma (n = 312).

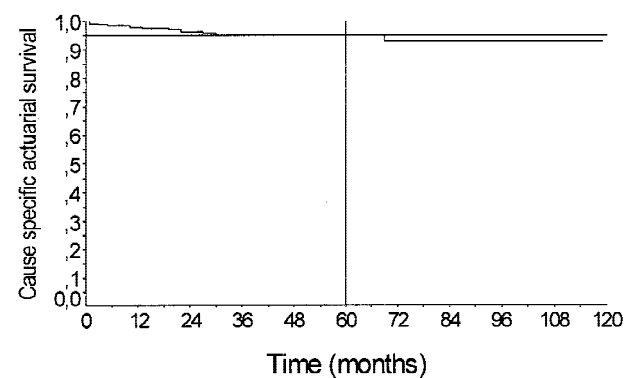


Fig. 4. Cause-specific actuarial survival—patients with glottic carcinoma stage I and II (n = 226).

## Functional Outcome

Seven of the 290 patients (2.4%) treated with TLS had tracheotomies during the course of their treatment. These included six out of the 49 patients treated for supraglottic carcinoma (13.0%)

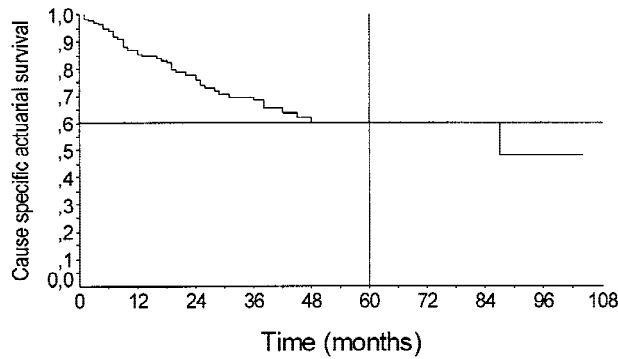


Fig. 5. Cause-specific actuarial survival—all patients with supraglottic carcinoma ( $n = 175$ ).

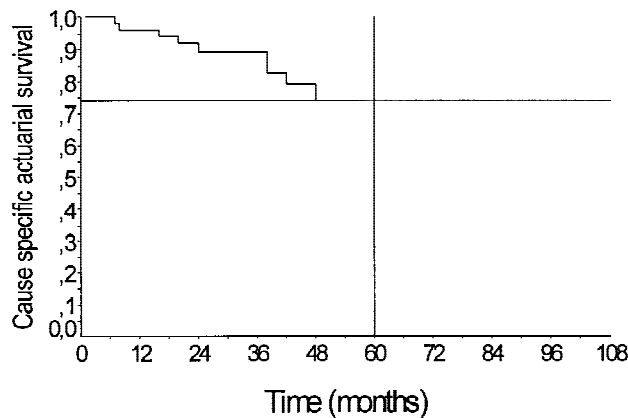


Fig. 6. Cause-specific actuarial survival—patients with supraglottic carcinoma stages I and II ( $n = 61$ ).

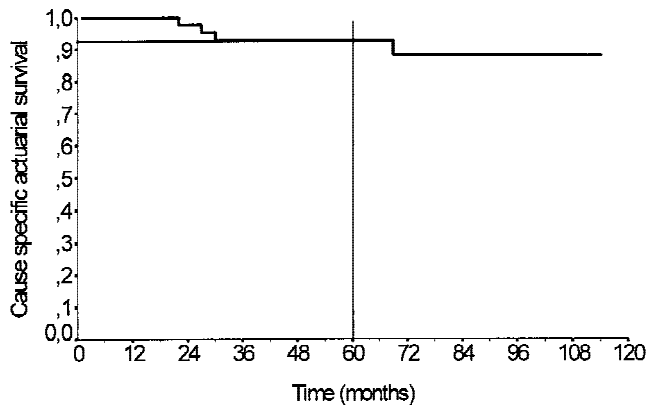


Fig. 7. Cause-specific actuarial survival for 66 patients with glottic carcinoma  $T_2N_0$  treated with laser surgery.

and one out of 232 patients treated for glottic carcinoma (0.43%).

Deglutition and phonatory outcome for the patients presented in this study have previously been reported and are not discussed in detail in this report.

One patient required further surgery due to a scar tissue stenosis of the glottis following TLS for an extensive bilateral carcinoma. No other clinically significant airway stenosis was observed in this series.

## DISCUSSION

The management of 504 consecutive patients with larynx carcinoma from one single institution is reported. TLS was the most frequently used therapeutic modality for the treatment of the primary. It accounted for the treatment of 290 out of 504 patients. Total laryngectomy was the second most frequently used approach to the primary ( $n = 130$ ), whereas radiation therapy ( $n = 34$ ) as single modality treatment and open partial laryngectomies ( $n = 31$ ) were less frequently used.

TLS has some well-known advantages over open surgical procedures: Tracheotomies are usually not required, perioperative morbidity is low, and hospitalization is usually short [9–12]. Tracheotomies have been identified to provide substantial negative impact on postoperative patient adjustment and quality of life following open partial surgery [21]. Deglutition seems to be less disturbed than after horizontal partial laryngectomy, and vocal function is usually satisfactory or good [12,15,22–23]. As compared to radiation therapy, TLR is faster accomplished for the patient and is obviously more cost-effective [17]. In the near future, innovations in the field of laser technology and instrumentation may contribute to even more precise tissue ablation modalities and improved functional results [24–26].

Despite these well-known advantages, endoscopic surgery continues to be considered a treatment modality for a small number of highly selected patients only [20,27]. Experimental and clinical studies have suggested that an endoscopic approach to glottic carcinoma may provide insufficient visualization of the tumor in a substantial portion of patients [27].

No study in the literature has so far described the relative percentage of patients with larynx carcinoma in unselected material from one or more institutions that have been treated with endoscopic laser surgery.

The data presented in this study suggest that TLS may potentially become the most important single treatment modality for early stage larynx carcinoma. These data were gained prospectively from a relatively large series of patients with sufficient follow-up to allow for oncological



**TABLE 2. Outcome After Transoral Laser Resection of Larynx Carcinoma Stages III and IV (n = 13)**

Site	Stage	TNM	Initial treatment <sup>a</sup>	Outcome <sup>b</sup>
Glottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, unilateral ND, XRT	Died of unknown cause 37 mo
Glottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, unilateral ND, refused XRT	Local recurrence after 15 mo > LE > NED 68 mo after LE
Glottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, unilateral ND, XRT	Alive with NED 66 mo
Glottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, unilateral ND, XRT	Died of unrelated disease with NED after 13 mo
Supraglottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Died 9 mo with regional and distant treatment failure (rT <sub>0</sub> N <sub>2</sub> M <sub>1</sub> , lung)
Supraglottis	III	T <sub>3</sub> N <sub>0</sub> M <sub>0</sub>	TLS, bilateral ND	Alive with NED 33 mo
Supraglottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Alive with NED 41 mo
Supraglottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Local and regional recurrence (rT <sub>4</sub> N <sub>2</sub> M <sub>0</sub> ) 43 mo > LE > died 2 mo after salvage surgery
Supraglottis	III	T <sub>1</sub> N <sub>1</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Alive with NED 24 mo
Supraglottis	III	T <sub>2</sub> N <sub>1</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Alive with NED 62 mo
Supraglottis	IV	T <sub>2</sub> N <sub>2</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Local and regional recurrence (rT <sub>3</sub> N <sub>2</sub> M <sub>0</sub> ) 20 mo > LE > died 8 mo after salvage surgery
Supraglottis	IV	T <sub>2</sub> N <sub>2</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Distant metastases (bone, liver) diagnosed after 36 mo with no evidence of local or regional treatment failure, died 45 mo (rT <sub>0</sub> N <sub>0</sub> M <sub>1</sub> , bone, liver)
Supraglottis	IV	T <sub>2</sub> N <sub>2</sub> M <sub>0</sub>	TLS, bilateral ND, XRT	Regional recurrence 11 mo (rT <sub>0</sub> N <sub>2</sub> M <sub>0</sub> ) > surgical salvage > NED 9 mo after salvage therapy

<sup>a</sup>TLS = transoral laser surgery of primary tumor; ND = neck dissection; XRT = radiotherapy.

<sup>b</sup>mo = month; LE = total laryngectomy; NED = no evidence of disease.

analysis. Survival rates, local control, and organ preservation are equivalent or even superior to those previously reported for standard therapies [15,19,22], although higher local control rates have recently been documented following open surgery [3,6,28–29]. Therefore, the data presented here suggest that TLS is no longer a treatment modality restricted to highly selected patients, but may well become a major treatment option for stages I and II carcinoma of the larynx and for carcinoma in situ. Since these stages represent the majority of all larynx carcinoma cases [5] (61.8% of all patients included in this study), it is obvious that TLS has the potential to become the most important single treatment modality for larynx carcinoma. In a recent survey on the patterns of care for cancer of the larynx in the United States, laser surgery accounted for 43.7% of all surgical interventions reported and for 24.8% of all treatment modalities during the 1990–1992 period, whereas it was used for only 34.2% of all surgical interventions reported and for 20.7% of all treatment modalities during the 1980–1985 period [5]. These data confirm the increasing importance of transoral laser surgery for the treatment of larynx carcinoma. In addition, recent reports in the literature suggest that TLS may further become an alternative approach even to more advanced stages [12,15,19]. However, TLS has to be combined with additional treatment to the neck in supraglottic carcinoma and in more ad-

vanced glottic cases if the oncological soundness of this approach is not to be sacrificed.

The treatment protocol used in this study, therefore, included neck dissections for patients with stages III and IV glottic carcinoma and for all with subglottic and supraglottic carcinoma. Additional postoperative radiotherapy was recommended if lymph node metastases were histologically evident, or if patients refused neck dissections that had been recommended as a part of the initial treatment protocol.

If local recurrence occurs, better re-treatment options are available as compared to initial radiotherapy or open surgery, since wound complications as a result of previous irradiation are not encountered and the laryngeal framework is still intact [30]. Therefore, such recurrences allow for further organ-sparing procedures if they are discovered timely. However, meticulous follow-up of these patients is required, if local recurrences are to be discovered early enough for further voice sparing therapy [31].

Only limited data on the functional outcome of laser surgery for larynx carcinoma are so far available from not-randomized trials [12,15,19,22,23]. Further prospective studies will be needed to determine the functional outcome with regard to voice, airway, and deglutition for TLS as compared to radiotherapy and conventional partial laryngectomies. If equally excellent oncological results can now be achieved with different treat-

ment modalities (radiotherapy, conventional partial laryngectomy, and laser surgery), perioperative morbidity, long-term functional results, and cost-effectiveness may become the most important end-points when considering different treatment modalities for larynx carcinoma. Therefore, further clinical research work needs to be directed toward the prospective assessment of these end-points.

## CONCLUSIONS

TLS was the most important single treatment modality in this series. It is a safe time- and cost-effective alternative to radiotherapy for early stage larynx carcinoma. The data presented in this study suggest that TLS is no longer a treatment modality that should be restricted to highly selected patients, but may well become a major treatment option for stages I and II carcinoma of the larynx and for carcinoma in situ. Since these stages represent the majority of all larynx carcinoma cases, TLS may become the most important single treatment modality for larynx carcinoma. Additional treatment options are required for the neck if suspect lymph nodes are detectable at the time of primary treatment, or if the neck is considered to be at risk for regional metastases. In light of the recent literature on treatment modalities for larynx carcinoma, the future may bring new roles for surgery and radiotherapy. Surgery, including TLS, may become a more widespread approach to early stage disease, whereas organ preservation programs based on sequential or concomitant chemotherapy and radiotherapy may replace surgery as the most important treatment modality in advanced but resectable stages.

However, no data gained from prospective studies on the quality of voice, breathing, deglutition, and patient satisfaction following different treatment modalities have so far been reported in the literature. Therefore, although the oncological soundness of laser surgery for larynx carcinoma is now well documented and the applicability of this therapeutic modality to large cohorts of unselected patients has been proven with the results of this study, further research work is needed to determine the functional outcome with respect to voice, airway patency, and deglutition as compared to radiotherapy and conventional partial laryngectomies.

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